Dynamic and Mechanical Properties of Calcium Borophosphate Glasses in Relation to Structure and Topology

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Abstract

Calcium borophosphate glasses and glass ceramics are of interest as bone-replacement implants as they can bond to bone through an apatite layer, and dissolve in vitro at a rate comparable to the growth rate of natural bone. We investigate the pseudo-binary join between $CaO{\cdot}P_2O_5$ and $CaO{\cdot}2B_2O_3$ because both end-members form glasses and the CaO/P_2O_5 ratio (which is related to bioactivity) varies from unity to infinity across the join. We explore the composition and structure dependence of the glass transition temperature, kinetic fragility, indentation hardness, and glass stability. We also study the crystallization behavior of this glass series. The compositional variation of these properties is analyzed using the Phillips-Thorpe rigidity percolation paradigm and the temperature dependent constraint theory. This analysis gives insight into the link between properties and composition in borophosphate glasses.